Circular No. 20.

United States Department of Agriculture,

DIVISION OF FORESTRY.

INCREASING THE DURABILITY OF TIMBER.

A large amount of timber and labor is wasted by lack of care for the timber after it is cut. Rotting of timbers and fence posts necessitates not only the cutting of a larger quantity of wood, but also the labor of replacing them oftener than if the wood could be made to last longer.

There are some rules in the handling of timber which are too often overlooked and which should be observed by everybody who uses wood in places where it can not be kept dry or wholly submerged.

There is also much unintelligent use of paints and other coatings which are applied in the hope of preserving timber, when it should have been well known that by painting green or badly seasoned timber decay is hastened rather than prevented.

While it may be impossible to apply the more complicated and expensive methods of wood preservation which recommend themselves to large consumers of wood material, a knowledge of the following points in relation to the decay and the preservation of timber will aid the small consumer to handle his material to better advantage, to utilize forest products more thoroughly and intelligently, and to make them last from two to three times as long as when such rules as herein given are not observed.

1. CONDITIONS OF DECAY OF WOOD.

The decay of wood is produced by fungi or low forms of plants. Some of these live merely on the protoplasm of the living cells or else convert and consume the starchy matter stored in wood, while the more formidable ones, the real destroyers of wood, dissolve the cell walls, and thus change a piece of hard wood into incoherent dust, converting part of the substance into sugar-like bodies for their food.

All these fungi require moisture for their development. Wood containing less than 10 per cent moisture is not subject to decay. The fungi require moderate warmth—cooled to near the freezing point they do not die, but cease to be active and to multiply; heated to 150° F. they die, and the wood is thereby disinfected for the time. They need the oxygen of the air—entirely submerged under water for a long time with exclusion of the air they perish, and the same seems to be the case when the wood is deeply buried, especially in impervious soils.

Containing more nitrogenous matter (protoplasm, etc.), starch, as well as wood substance, the sapwood is much more subject to the attack of fungi than the heartwood in which nitrogenous matter and starch are wanting, and in which, moreover, decay-resisting and even disinfectant substances are formed or accumulated (tannins, resins, besides bodies whose value is not yet fully understood).

Thus no sapwood in the natural state is durable—even the sapwood of durable woods like oak, cedar, etc., readily decays.

2. MANNER OF USE INFLUENCES DURABILITY.

From what has been said, it follows that wood lasts better in cold countries and cold places, is safe either under water or deeply buried in the ground, or if constantly saturated, as in a conduit, and that it resists decay if kept dry or hot. A thin fence rail seasons and lasts; a thick one of the same wood rots before it can season. A thin picket lasts longer than a log, and a picket without paint lasts better than one which has been painted before it was really dry. Fence posts, railway ties, bridge and trestle timbers, which are alternately dry and wet and never season, especially at the points of contact, like the sills of houses and timbers in badly ventilated cellars, basements, wells, and mines, are especially subject to decay.

Nearly all our knowledge concerning durability of woods is based on observations of wood as posts, sills, and ties. Boards are apt to be better seasoned before use, and beams also have a better opportunity for drying out before decay commences. Where boards or timbers in houses are covered with paint before becoming dry, as mopboards and wainscot often are, they decay in a manner usually spoken of as "dry rot." They may never be wet, but they were never really dry.

If wood is used in contact with the ground, decay proceeds the more rapidly (beginning at the point of contact with the soil) the looser, moister, and warmer the soil, especially the greater the liability of change from dry to wet; therefore, timber will last longer in heavy, always moist clay, than in loose, alternately moist and dry sand or gravel, or in warm, comparatively dry lime soils.

3. NATURAL FACTORS INFLUENCING DURABILITY.

Generally logs of young trees, containing a larger proportion of sapwood (50 to 90 per cent), furnish less durable wood than logs of older trees. This is because of the preponderance of sapwood, which is often overlooked, especially in the use of posts, piles, and poles, for which young wood is most frequently employed. Wood of very old, "over-ripe" timber, it has often been claimed, is less durable than young timber. It is questionable whether this claim can be substantiated, and even the railway companies of this country are beginning to waive the point of age as well as the size of tree in the selection of ties.

Well grown, thrifty timber is generally believed to furnish the most durable wood, but in pine and other conifers the slow grown timber is preferred. So far, this preference seems to be mostly a matter of prejudice, for even in the market the slower grown oak is

often preferred, and certainly the rapidly grown white pine heartwood, contrary to the general belief, makes a sidewalk of great durability. The common belief that the timber from the swamp is less durable than that from high ground seems, like many other tenets on this subject, without foundation.

4. LIST OF MORE DURABLE AND LESS DURABLE TREES.

The following list of trees comprises most of those of common occurrence, arranged more or less according to their relative durability. Without means of determining the exact relative value of the different species, it has been possible to give only a series which in general proceeds from the more durable to less durable ones.

EASTERN RANGE.

The more durable trees are:

CONIFERS.—Red Cedar (*Juniperus virginiana*); White Cedar (*Chamæcyparis thyoides*); Arborvitæ (*Thuja occidentalis*); Bald Cypress (*Taxodium distichum*); Tamarack (*Larix laricina*); Longleaf Pine (*Pinus palustris*); Cuban Pine (*Pinus heterophylla*); Loblolly Pine (*Pinus taeda*); Shortleaf Pine (*Pinus echinata*); Pitch Pine (*Pinus rigida*); White Pine (*Pinus strobus*); Hemlock (*Tsuga canadensis*); Red Pine (*Pinus resinosa*); Jack Pine (*Pinus divaricata*); Spruce (*Picea mariana* and *canadensis*).

BROAD-LEAFED TREES.—Live Oak (*Quercus virginiana*); Osage Orange (*Toxylon pomiferum*); Red Mulberry (*Morus rubra*); Black Locust (*Robinia pseudacacia*); Catalpa (*Catalpa catalpa*); The White Oaks, including White Oak (*Quercus alba*), Post Oak (*Quercus minor*), Bur Oak (*Quercus macrocarpa*), Cow Oak (*Quercus michauxii*), Overcup Oak (*Quercus lyrata*); Black Walnut (*Juglans nigra*); Chestnut (*Castanea dentata*); Sweet (Red) Gum (*Liquidambar styraciflua*); Tulip tree (Yellow Poplar) (*Liriodendron tulipifera*).

Less durable trees are:

Elm (*Ulmus* sp.); Ash (*Fraxinus* sp.); Red Oak (*Quercus rubra*, etc.); Basswood (*Tilia*).

Trees not durable are:

Hickory (*Hicoria* sp.); Maple (*Acer* sp.); Beech (*Fagus*); Blue Beech (*Carpinus*); Birch (*Betula* sp.).

ROCKY MOUNTAIN REGION.

Red Cedar (*Juniperus virginiana*); Piñon (*Pinus edulis*); Foxtail Pine (*Pinus balfouriana*); Douglas Spruce (*Pseudotsuga mucronata*); Western Larch (*Larix occidentalis*).

PACIFIC SLOPE.

Yew (*Taxus brevifolia*); Redwood (*Sequoia sempervirens*); Pacific Arborvitæ (*Thuja plicata*); Yellow Cedar (*Chamæcyparis nootkatensis*); Port Orford Cedar (*Chamæcyparis lawsoniana*); Cañon Live Oak (*Quercus chrysolepis*); Pacific Post Oak (*Quercus garryana*).

5. TIME OF FELLING.

With proper aftertreatment of the wood, the time of felling seems not to affect its durability. Winter felling is generally preferable to summer felling, because both fungi and insects are then inactive, and the timber may be handled more at leisure, both in the woods and during shipment and conversion, and, if worked up at once, has a chance to season to quite an extent before warm weather awakens its many enemies. Where logging and milling is carried on in a large way, and the log is cut into boards and these put through the dry kiln before the fungi and beetles have a chance to attack them, the product of summer felling is as good as that of any winter-felled timber.

Where logging is done in a small way the cutting of timber in summer usually involves loss, and commonly leads to inferior product.

Peeling standing timber and allowing it to season on the stump is often recommended, but has never found favor in this country. Girdling timber to partially season it is done for cypress, but with indifferent success.

To cut down trees and allow them to leaf out before cutting into logs is often recommended, and it is claimed that this will lead to a complete removal of sap and stored reserve food (starch) and thereby increase durability. It is not practiced in this country.

6. TREATMENT AFTER FELLING.

If timber is to remain in the log (as export timber, etc.) peel, cover the ends with cheap paint, and always place on skids. Work up any kind of timber as soon as possible.

Never leave any wood, not even cordwood, piled on the ground; raise it on crosspieces, and, if it is valuable material (cooperage, wagon, or other stock) pile with care, give to all parts of the pile a chance for circulation of air, and if possible cover the pile to shut out the direct sun. Thick material must have thick crosspieces, and all sawed material given to warping (sycamore, gum, oak, etc.) must be piled with special care; the crosspieces must be ample in thickness as well as in number, and must be regularly placed.

In ordinary yard seasoning "one year for every inch in thickness" is an old rule. Inch stuff of hard woods can be seasoned well by air-drying six months and then placing them in dry kiln or hot room. Conifers of all kinds can be dried very well by placing in dry kiln fresh from the saw. Dry-kiln seasoning disinfects lumber and thereby does much to increase durability.

Immersion in water for safe storage of wood is an old custom; it also improves the sapwood, since it allows the nitrogenous materials and part of the carbohydrates to be removed by fermentation without admitting the real wood-destroying fungi. Boiling and steaming, it is claimed, serve a similar purpose, and that all water treatments facilitate seasoning. Experiments on a large scale have not proven encouraging in this respect. The common assertion that rafting and hot-water treatment injure the wood by reducing its strength is entirely unsubstantiated. Long-time immersion hastens the darkening of wood.

7. COATINGS TO KEEP OUT MOISTURE AND PRESERVE WOOD.

Never apply paint or any other coating to green or unseasoned timber. If the wood is not well dried or seasoned the coat will hasten decay. Oil paints are used to increase the durability by protecting the wood against moisture. An exposed unpainted board becomes gray and fuzzy, warps and checks, the nails rust out, and even if it is not exposed to rain, damp air, steam, etc., occasion similar mischief.

For coating, coal tar, with or without sand or plaster, and pitch, especially if mixed with oil of turpentine and applied hot (thus penetrating more deeply), answers best. A mixture of three parts coal tar and one part clean unsalted grease, to prevent the tar from drying until it has had time to fill the minute pores, is recommended. One barrel of coal tar ($3 to $4 per barrel) will cover 300 posts.

Both tar and oil paint have the disadvantage that they act as mere covers. If the wood has any chance to get moist before painting they are harmful instead of useful.

Heavy tar oils, freed of their volatile as well as their thick tarry constituents, such as are now offered in the market under the name of Carbolineum, are preferable to paints and tars.

These oils penetrate and act as antiseptics, actually killing the fungi or at least retarding their action and development. They are applied with brush or else as baths, usually and preferably hot. They can not replace paints where the looks of the material are to be improved.

Charring assists merely as an insulator, separating the wood from the ground, and as fungi can not eat their way through charcoal they are prevented from entering. Generally, however, the process develops large cracks and thus exposes the interior to the attacks of fungi.

Lastly, in communities where durable timber is scarce, and where, as in railroad building, large amounts of wood are used in situations which favor decay, it will pay to establish a plant for impregnating timber with antiseptics by the more costly processes described in Bulletins Nos. 1 and 9 of the Division of Forestry.

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Approved:
James Wilson,
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